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Dynamic Simulation and Path Planning for Virtual Environments

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11. SUPPLEMENTARY NOTES

The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designated by other documentation.

12a. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution unlimited.

12 b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The PI and his students have developed novel algorithms for collision detection, 3D polyhedral morphing and view frustrum culling. These include use of noval hierarchical data structures and geometric techniques for interactive occlusion culling, general 3D mapping algorithm and efficient collision detection between general polygonal models.

The resulting algorithms and systems have been applied to a number of applications and the technology has been transferred to a number of research labs and academic institutes, as well as commercial vendors.

14. SUBJECT TERMS

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Contract No. DAAH04-93-D-0001

PROJECT TITLE: Dynamic Simulation and Path Planning for Virtual Environments

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1. Technical Objectives and Motivation

We are addressing some fundamental research issues in dynamic simulation and path planning for virtual environments and electronic prototyping. Our emphasis is to develop better algorithms and software systems and to demonstrate their applications. The set of problems include:

A. Rapid and accurate algorithms for collision detection and distance computation between general geometric models and deformable bodies

B. Robust and efficient system implmentation and software libraries based on the proposed algorithms

C. Applications to virtual environments and electronic prototyping

2. Approach

We are utilizing number of techniques from algebraic geometry, approximation theory, computational geometry, numerical analysis, computer-aided geometric design and computer graphics to investigate the underlying mathematical concepts and to develop more efficient and robust geometric algorithms. This includes algorithms and systems for computing correspondence between two general polyhedra, occulsion culling and interactive collision detection between moving objects.

3. Significant Accomplishments

The PI and his students have developed novel algorithms for collision detection, 3D polyhedral morphing and view frustrum culling. These include use of noval hierarchical data structures and geometric techniques for interactive occlusion culling, general 3D mapping algorithm and efficient collision detection between general polygonal models.

The resulting algorithms and systems have been applied to a number of applications and the technology has been transferred to a number of research labs and academic institutes, as well as commercial vendors.

4. Cooperation with and Technology Transfer to Army Laboratories and Other Organizations

{\bf I-COLLIDE, RAPID and V-COLLIDE Collision Detection Systems:}
More than 1200 users all over the world have copied the source code of the I-COLLIDE, RAPID and V-COLLIDE collision detection systems.
Some of the prominent users are at Sandia National Labs, Lockheed Martin, Ford Motor Company, Division, Engineering Animation, Army Research Labs, Evans and Sutherland, etc. The system has also been licensed to Mechanical Dynamics Inc., Division, Prosolvia etc.

5. Publications in Refereed Journals and Conference Proceedings

{\sf A. Gregory, A. State, M. Lin, D. Manocha and M. Livingston},
''Feature-based Surface Decomposition for Correspondence and Morphing between Polyhedra'', to appear in the Proceedings of Computer Animation, June 1998.

{\sf S. Krishnas, G. Meenakshi, M. Lin, D. Manocha and A. Pattekar},
''Rapid and Accurate Contact Determination between Spline Models Using ShellTrees'', to appear in the Proceedings of Eurographics, September 1998.

{\sf S. Krishnas, A. Pattekar, M. Lin and D. Manocha},
''Spherical Shells: A Higher Order Bounding Volume for Fast Proximity Queries'', in the Proceedings of {\em International Workshop on Algorithmic Foundation of Robotics}, Houston, TX, March 1998.

{\sf Ming C. Lin and Dinesh Manocha} (1997),
''Efficient Contact Determination in Dynamic Environments'',
in the Special Issue of {\em International Journal of Computational Geometry and Applications}, Vol. 7, No. 1 \& 2, pp. 123-151.

{\sf Madhav K. Ponamgi, Dinesh Manocha and Ming C. Lin} (1997),
''Incremental Algorithms for Collision Detection between Polygonal Models",
in {\em IEEE Transaction on Visualization and Computer Graphics},
Vol. 3, No. 1, Jan-Mar 1997, pp. 51--64.

{\sf T. Hudson, D. Manocha, J. Cohen, M. C. Lin, K. Hoff, H. Zhang},
''Accelerated Occlusion Culling using Shadow Frusta'',
in the {\em 13th ACM Symposium on Computational Geometry},
pp. 1-10, Nice, France, 1997.

{\sf Tom Hudson, Ming C. Lin, Jon Cohen, Stefan Gottschalk and Dinesh Manocha}, ''V-COLLIDE: Accelerated Collision Detection for VRML'',
in the {\em Proceedings of ACM Symposium on Virtual Reality Modeling Language Symposium}, pp. 119-125, Monterey, CA, 1997.

6. Awards and Honors (if any, omit this section if none)

Honda Research Initiation Award

7. Papers or reports in non-refereed publications

None

8. Books or book chapters published

{\sf Ming C. Lin and Dinesh Manocha} (1998),
''Applied Computational Geometry'', Invited Contribution,
{\em Encyclopedia of Computer Science and Technology},
Vol. 38, No. 23, pp. 17-28,
edited by A. Kent and J. G. Williams, Marcel Dekker, Inc.

{\sf Ming C. Lin} (1997),
''Building Simulations for Virtual Environments and Prototyping''
Award Winning Papers on Army Sciences and Technology,
pp. 34-38, published by {\em World Scientific}.

item {\sf Ming C. Lin, Dinesh Manocha, Jonathan D. Cohen and Stefan Gottschalk} (1997),
''Efficient Algorithms for Interference Detection in Dynamic Environments'',
in the book {\em Product Modeling for Computer Integrated Design and Manufacture}, edited by M. Pratt, R. D. Sriram and
M. J. Wozny, Chapman \& Hall, pp. 334--346.

9. Patent/Inventions filed or granted

None

10. Number of graduate and undergraduate students supported by gender and by minority group

Arthur Gregory (BS, Dec 1997; male)
Amol Pattekar (MS expected in May 1998; male)
Stefan Gottschalk (Ph.D. expected in August 1998; male)
Gentaro Hirota (Ph.D. expected in 2000/2001; male)

11. Number of MS and Ph.D. degrees awarded to students working through the grant and their current employment status and employers

None at this time

12. Nonexpendable instrumentation purchased; value thereof

None